

Effectiveness of Manipulative Materials on the Mathematical Competence of Grade 4 Pupils: A Basis for the Development of an Action Plan

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Abstract. This study aimed to develop an action plan proposing the integration of manipulative materials into regular teaching practices to further improve mathematical competence of the grade 4 pupils.. A total of 60 Grade four learners in the Labon Elementary School in the Sulop District, Division of Davao del Sur were identified through purposive sampling. A researcher-made test questionnaire was utilized in the gathering of data. Mean, Sample T-test, were used as statistical tools of the study. Results revealed on the pretest mean score of the control group and experimental group; both had fairly satisfactory mean before being exposed to the manipulative materials. In addition, on the posttest mean score it was revealed that the experimental group, which was exposed to the manipulative materials, demonstrated a higher posttest mean score categorized as outstanding, compared to the control group. Moreover, on the significant difference between the mean gains scores of students revealed that there is a statistically significant difference between the two groups' posttest scores. Lastly, a comprehensive action plan will be designed to systematically integrate manipulative materials into regular teaching practices, ensuring a more structured and effective approach to mathematics instruction. Thus, the study recommends teachers should be proactive in participating in professional development sessions that focus on the effective use of these materials to create a more interactive and engaging learning environment for students.

KEY WORDS

1. Manipulative materials
2. mathematical competence
3. quasi-experimental design

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1. Introduction

Mathematics serves as the foundation and instrument for the educational, technological, and economic development of any nation. This essential subject, studied in elementary and high school, equips students with foundational information and skills for daily structure. However, poor competence in mathematics is a significant worry for numerous countries worldwide.

Despite the esteemed status and accepted significance of mathematics, as well as its role as an essential foundation for other subjects, low competence in mathematics among learners remains to be a pressing matter in schools in both developed and developing nations. Mathematics is one of among the most formidable subjects in educational institutions, as viewed by learners.

Moreover, local educational examinations in Davao del Sur indicate that Grade 4 students frequently underperform in mathematics. A study by Dumigsi and Cabrella (2020) underscores similar problems in the region, revealing that students have difficulty acquiring essential mathematical concepts. The research evaluated the effectiveness of Strategic Intervention Materials (SIM) as an educational remedial tool for Grade 9 students, demonstrating that tailored instructional methods can significantly enhance student comprehension and performance. Their findings indicated that students who employed SIM attained satisfactory performance levels in comparison to their classmates who did not utilize these tools. This result highlights an urgent necessity for educators to adopt innovative pedagogical methods to address the disparity in mathematical competency at the elementary level.

The current body of research revealed a pervasive problem with mathematical competence affecting students at global, national, and local levels, including the Davao Region. Despite the many different instructional strategies employed by schools to mitigate these challenges, the issue remained unresolved. The researcher's goal was to find out how manipulative materials affected students' competence in mathematics. The study aimed to provide empirical evidence in the school environment of Davao City and to enhance the formulation of targeted and effective learning techniques for improving learners' mathematical competencies.

The specific objectives of the study are the following: a.) to determine the pre-test score of the Grade 4 pupils in the control and experimental groups before exposure to manipulative materials. b.) to determine the post-test score of the Grade 4 pupils in the control and experimental groups after exposure to manipulative

materials. c.) to determine if there is a significant difference between the pre-test and post-test scores of the Grade 4 pupils in the control group and experimental group, and d.) to develop an action plan to enhance mathematical competence of the Grade 4 pupils.

At .05 level of significance, the following hypothesis was tested: a.) There is no significant difference between the pre-test and post-test scores of the Grade 4 pupils in the control group and experimental group.

The study provided valuable insights for various stakeholders: For the Department of Education, it offered a strategic framework to improve students' mathematics competencies through evidence-based policies, better curriculum, teacher training, and resource allocation. Teachers gained guidance on effective instructional strategies and professional development, empowering them with tailored materials and mentorship to boost both teaching effectiveness and student outcomes. Learners benefited from an action plan that enhanced mathematical skills, reduced anxiety, and fostered confidence, leading to improved academic performance. For future researchers, the study laid a foundation for further exploration of effective math education strategies, highlighting existing gaps and offering a benchmark for comparative studies across different contexts.

Figure 1 depicted the progress of the study. This study employed the input-process-output framework, with the survey's input including the utilization of manipulative materials and the mathematical competence of grade four pupils. The process involved an assessment utilizing a test-type questionnaire, an instrument crafted to appraise the mathematical competence of grade four pupils, with the expected output being the action plan to enhance the mathematical competence of the grade four pupils.

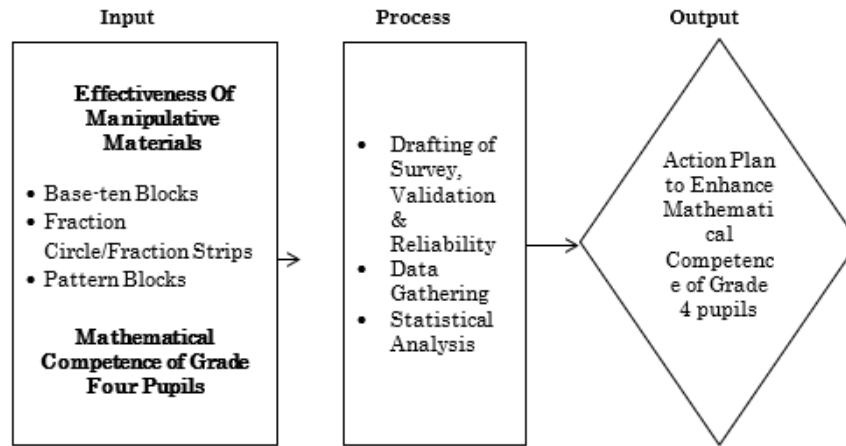


Fig. 1. Conceptual Framework

2. Methodology

This section delineates the methodologies employed by the researcher to conduct the study. It encompasses the population and sampling, instrumentation, data source, and data analysis.

2.1. Research Design—This study employed a quasi-experimental, non-equivalent pretest-posttest control group design, suitable for educational settings due to the lack of random assignment (Gopalan et al., 2020). Two intact Grade 4 groups participated: the experimental group received the intervention using manipulative materials, while the control group underwent conventional teaching. Pretest and posttest assessments were conducted to determine the intervention’s effectiveness by comparing mean scores. The study was guided by the Input-Process-Output (IPO) Model, which structured the research into three phases: identifying influencing variables (input), evaluating changes (process), and presenting findings with an action plan to improve mathematical competence (Suryadi Santoso, 2022). The IPO model also supported both descriptive and inferential analysis, helping examine the “what,” “why,” and “how” of the results (Feldman, 2025). Overall, this approach allowed for an in-depth analysis of student performance and informed strategies to enhance mathematics learning.

2.2. Ethical Consideration—The researcher strictly followed the ethical standards

set by RMC’s Research Ethics Committee, addressing core principles such as social value, informed consent, participant vulnerability, risks, safety, researcher qualifications, facility adequacy, privacy, confidentiality, anonymity, conflict of interest, justice, and transparency. The study aimed to enhance Grade 4 pupils’ mathematical competence in Sulop District, benefiting students, teachers, parents, and the broader community. Informed consent was obtained from both pupils and their guardians through age-appropriate communication, ensuring voluntary and well-informed participation. Measures were in place to address participant vulnerability, maintain privacy, and ensure data security in compliance with the Data Privacy Act of 2012. Safeguards were implemented to minimize risks and maximize benefits, with participants free to withdraw at any time. Transparency was upheld through clear communication, accurate reporting, and dissemination of results in professional settings, reinforcing the study’s integrity and ethical soundness.

2.3. Research Respondents—The study was conducted at Labon Elementary School in Sulop District, Division of Davao del Sur, using

purposive sampling to select participants based on specific criteria relevant to the study's objectives. Two intact Grade 4 classes were selected, with 30 pupils in the experimental group and another 30 in the control group. A pretest was administered to both groups, after which the experimental group received instruction using manipulative materials, while the control group received traditional lecture-based teaching. The intervention was carried out over two grading

periods (second and third quarters), with regular 50-minute sessions, all supervised by the researcher.

2.4. Research Instrument—The researcher developed a validated 25-item test, guided by a table of specifications, to assess Grade 4 pupils' mathematical competence. Both experimental and control groups took pretests to establish pretests and posttests to measure improvement, enabling a reliable comparison.

2.5. Data Gathering Procedure—The researcher followed a rigorous process to ensure accurate data collection and analysis. Permission was secured from the Division Superintendent and the Dean of the Graduate School, followed by coordination with school heads. The test instrument underwent expert content validation and pilot testing with non-participant pupils

to ensure reliability. Questionnaires were administered in person to build rapport and encourage honest responses, with ample time provided for completion. Once finalized, the questionnaires were securely retrieved and reviewed for completeness. Data analysis was conducted using SPSS, applying appropriate statistical methods to ensure valid and reliable results.

2.6. Data Analysis—The study employed data analysis tools such as the mean to assess the gain scores of Grade 4 pupils before and af-

ter using manipulative materials, and the t-test to determine significant differences between the pre- and post-test scores of the control and experimental groups

3. Results and Discussion

This section highlighted the results and discussions of the study. The presentation started with the discussion on the pretests scores of the Grade 4 pupils in the control and experimental groups before exposure to manipulative materials and posttest scores of the Grade 4 pupils in the control and experimental groups after exposure to manipulative materials. Followed by, the discussion on the significant difference of the mean gain scores of the two groups. Finally, an action plan will be developed proposing the integration of manipulative materials into regular teaching practices to further improve mathematical competence of the grade 4 pupils.

3.1. Pretests scores of the Grade 4 pupils in the control and experimental groups before exposure to manipulative materials—Table 1 presented the pretests scores of the Grade 4 pupils in the control and experimental groups before exposure to manipulative materials. Based on the result, the pretest mean scores of both the control and experimental groups

were interpreted as fairly satisfactory; this also means that the mathematical competence of the pupils showed basic mathematical competence. The control group achieved a total score of 19.59 which was equivalent and transmuted to 75, while the experimental group recorded a slightly higher total score of 21.73 which was equivalent to 77 when transmuted. These results

indicate that, prior to the exposure on the intervention, both groups exhibited similar mathematical competence, with no significant disparity between their performance levels. This also means that the mathematical competence of the grade 4 pupils was basic and struggles with con-

sistency and needs reinforcement in applying concepts accurately. This establishes a baseline for comparing the effectiveness of utilizing manipulative materials in enhancing the mathematical competence of the grade 4 pupils.

Table 1. Pretest Scores of the Grade 4 Pupils in the Control and Experimental Groups Before Exposure to Manipulative Materials

Group	N	Score	Mean	Descriptive Interpretation
Control Group	30	19.59	75	Fairly Satisfactory
Experimental Group	30	21.73	77	Fairly Satisfactory

3.2. Posttest scores of Grade 4 pupils in the control and experimental groups after exposure to manipulative materials—Table 2 flaunted the results on the posttest scores of the Grade 4 pupils in the control and experimental groups after exposure to manipulative materials. The results highlighted a notable difference in the mathematical competence of the control and experimental groups after the exposure to the intervention. The control group achieved a total score of 27.83, which was equivalent to the mean of 82 when transmuted indicating that the scores of the learners were satisfactory, indicating proficiency but requiring occasional support. On the other hand, the experimental group, which was exposed to manipulative materials,

attained a significantly higher score of 33.47 which was equivalent to 90, interpreted as outstanding, which means that the pupils in experimental group demonstrates exceptional mathematical competence, consistently applying advanced problem-solving skills with accuracy and efficiency. This significant rise indicates that the utilization of manipulative materials as a means of instruction effectively improved the mathematical competence of the Grade 4 students. These resources facilitated the accessibility and engagement of abstract mathematical topics through hands-on learning experiences. Consequently, pupils demonstrated considerable enhancement in their mathematical abilities, underscoring the efficacy of this method in promoting profound comprehension.

Table 2. Posttest Scores of Grade 4 Pupils in the Control and Experimental Groups After Exposure to Manipulative Materials

Group	N	Score	Mean	Descriptive Interpretation
Control Group	30	27.83	82	Satisfactory
Experimental Group	30	33.47	90	Outstanding

3.3. Significant difference between the pretest and posttest scores of the Grade 4 pupils

in the control group and experimental group—Table 3 revealed the analysis of the signifi-

cant difference between the pretest and posttest scores of the Grade 4 pupils in the control and experimental groups. The result shows a clear distinction in their posttest performance. With a t-value of 8.021 and a p-value of .000, the results indicate a statistically significant differ-

ence between the two groups. This implies that the intervention, specifically the use of manipulative materials, had a substantial positive effect on the mathematical competence of the experimental group compared to the control group, which did not receive the same intervention.

Table 3. Significant Difference Between the Mean Gain Scores of the Students in the Control Group and Experimental Group

Variable Paired	N	df	t-value	p-value	Descriptive Interpretation
Posttest of Control Group and Experimental Group	60	58	8.021	.000	Significant

3.4. Action plan to enhance the mathematical Competence of the Grade 4 pupils—Table 4 presented an action plan enhance the mathematical competence of the grade 4 pupils. The plan outlines strategies designed to improve students' skills, with a focus on incorporating manipulative materials into lessons. The expected outcome is a significant improvement in the mathematical competence of the experimental group, as evidenced by higher posttest scores. These results will serve as a foundation for refining instructional strategies, emphasizing the importance of hands-on learning tools. y continuously assessing and adapting the use of manipulatives, the action plan aims to create a more engaging and effective learning environment for the students.

3.4.1. Target Competency: —The action plan aims to enhance the mathematical competence of Grade 4 pupils by strengthening their ability to understand and apply fundamental mathematical concepts and problem-solving strategies. This includes improving their skills in areas such as computation, logical reasoning, and conceptual understanding. Through consistent practice, guided exploration, and strategic use of manipulatives, students are expected to demonstrate measurable growth in their mathe-

tical performance, as reflected in improved posttest scores and greater confidence in handling math-related tasks.

3.4.2. Focus:—The central focus of the action plan is the systematic integration of manipulative materials into daily mathematics instruction. By embedding hands-on learning tools into regular lessons, the plan promotes active student engagement and supports diverse learning styles. This approach not only facilitates a deeper conceptual grasp of mathematical principles but also encourages exploration and collaborative learning. Ultimately, the focus on manipulatives aims to shift classroom instruction from rote memorization to experiential learning, thereby enhancing both the effectiveness and enjoyment of mathematics education for Grade 4 pupils.

3.4.3. I. Objective—To seamlessly integrate a diverse range of manipulative materials into the Grade 4 mathematics curriculum, fostering a deeper comprehension of mathematical concepts while simultaneously enhancing students' problem-solving abilities and critical thinking skills. This strategic approach aims to create a more engaging and interactive learning environment, ultimately leading to more holistic and meaningful academic outcomes.

To significantly elevate student engagement and foster active participation in the exploration and deep understanding of mathematical concepts through hands-on, experiential learning opportunities.

To deepen students' grasp of abstract mathematical concepts by offering tangible, visually engaging representations that bridge the gap between theory and real-world application.

To substantially improve student performance

on mathematical assessments, as demonstrated by a measurable increase in pretest and posttest scores, thereby validating the effectiveness of the manipulative-based learning approach.

To empower educators with the expertise, confidence, and practical skills necessary to seamlessly integrate manipulative materials into their teaching practices, thereby creating a more dynamic, engaging, and enriching learning experience for students.

4. Conclusions and Recommendations

3.4.4. Goals— This study aimed to determine the pretests scores of the Grade 4 pupils in the control and experimental groups before exposure to manipulative materials and posttest scores of the Grade 4 pupils in the control and experimental groups after exposure to manipulative materials. Followed by, the discussion on the significant difference of the mean gain scores of the two groups. Finally, an action plan will be developed proposing the integration of manipulative materials into regular teaching practices to further improve mathematical competence of the grade 4 pupils. The following are the significant findings:

4.1. Findings—prior to the intervention, both the control and experimental groups demonstrated comparable levels of mathematical competence, as reflected in their pretest scores, which were categorized as fairly satisfactory. The slight difference in mean scores between the two groups indicates that their initial performance did not significantly vary, establishing a baseline for evaluating the impact of manipulative materials on their learning outcomes. This implies that any subsequent improvements observed in the experimental group can be attributed to the effectiveness of the intervention rather than pre-existing differences in mathematical ability.

In contrast, the experimental group, which was exposed to manipulative materials, while the control group showed minimal progress with a posttest mean score within the satisfactory range, the experimental group exhibited a

remarkable increase, achieving a outstanding mean score. This substantial improvement highlights the effectiveness of manipulative materials in enhancing mathematical competence. The hands-on learning approach provided by these resources enabled pupils to engage more deeply with abstract mathematical concepts, resulting in a notable enhancement of their mathematical abilities. These results underscore the efficacy of using manipulative materials as an instructional method to foster a deeper understanding of mathematical concepts among Grade 4 students.

4.2. Conclusions—On the significant difference between the pretest and posttest scores of the Grade 4 pupils in the control and experimental groups; the findings indicate a statistically significant difference between the posttest scores of the control and experimental groups, as evidenced by the obtained t-value and p-

value. This confirms that the use of manipulative materials had a substantial positive impact on the mathematical competence of the experimental group. The significant improvement in their performance suggests that hands-on learning strategies effectively enhance students' understanding of mathematical concepts. In contrast, the control group, which did not receive the intervention, exhibited only minimal progress.

For the qualitative data, the incorporation of manipulative materials in Grade 4 mathematics instruction is anticipated to enhance student engagement and mathematical competence. This action plan offers a systematic framework to provide educators with essential resources, training, and assessment, with the objective of fostering a more efficient and engaging learning atmosphere. The expected results will boost student performance and foster the ongoing ad-

vancement of instructional methodologies.

4.3. Recommendations—Based on the study's conclusions, it is recommended that the Department of Education integrate manipulative materials into the curriculum to enhance mathematical competence, providing resources and training for effective implementation. School heads should support this initiative by ensuring access to materials and professional development for teachers, while also monitoring student progress and gathering feedback. Teachers are encouraged to use manipulatives to boost student engagement and understanding, tailoring them to learners' needs and participating in relevant training. Students should actively engage with these materials to improve their grasp of abstract concepts. Future researchers are advised to explore the long-term impact of various types of manipulatives on student learning across different mathematical domains.

5. References

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Table 4. Action plan to enhance mathematical competence of Grade 4 pupils

Action Step	Timeline	Actions	Resources Needed	Expected Outcome
1. Preparation and Resource Identification	1 month	Identify and gather suitable manipulative materials to facilitate Grade 4 mathematical topics, hence augmenting experiential learning and skill development.	P10,000 for materials	Ready supply of manipulative materials; align materials with the Grade 4 mathematics curriculum.
2. Teacher Training and Orientation	2 weeks	Facilitate workshops to provide educators with techniques for using manipulatives in their lessons, promoting interactive and engaging learning environments.	P5,000 for training and workshop	Teachers equipped with strategies for using manipulatives; demonstrate methods for dynamic, student-focused classes fostering critical thinking and engagement.
3. Pilot Implementation of Manipulative Materials	3 months	Implement materials in an experimental group and monitor progress.	Materials identified in Step 1	Improved student engagement and understanding in the experimental group; gather feedback from teachers and students.
4. Evaluation and Data Collection	Ongoing (end of each term)	Compare pretest and posttest scores to evaluate impact.	Pretest/posttest materials; teacher surveys	Assessment data to measure effectiveness; collect teacher feedback on integration process.
5. Review and Refine Strategies	End of school year	Analyze data and refine strategies for the use of manipulative materials.	Data analysis tools; teacher collaboration time	Improved teaching methods and better integration of materials; share effective strategies with other teachers.
6. Scaling and Continuous Improvement	Year 2 onwards	Expand manipulative materials use across all Grade 4 classrooms.	Additional resources as needed; continued teacher training (P5,000)	Broader implementation of manipulatives; sustained improvement in student outcomes.